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Optimising feedback for early career professionals: a scoping review and new framework

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Abstract

Introduction: Meta-analyses have shown that feedback can be a powerful intervention to increase learning and performance but there is significant variability in impact. New trials are adding little to the question of whether feedback interventions are effective, so the focus now is how to optimise the effect. Early career professionals (ECPs) in busy work environments are a particularly important target group. This literature review aimed to synthesise information to support the optimal design of feedback interventions for ECPs.

Methods: We undertook a scoping literature review, using search terms such as 'feedback' and 'effectiveness' in MEDLINE; MEDLINE-in-Process; PsycINFO; CINAHL; Education Research Complete; ERIC; Cochrane Database of Systematic Reviews; Social Science Citation Index; and ASSIA, to identify empirical studies describing feedback interventions in busy workplaces published in English since 1990. We applied inclusion criteria to identify studies for the mapping stage and extracted key data to inform the next stage. We then selected a subset of papers for the framework development stage, which were subjected to a thematic synthesis by three authors leading to a new Feedback Framework and a modified version of Feedback Intervention Theory specifically for ECPs.

Results: Eighty studies were included in the mapping stage, with roughly equal studies from hospital settings and school classrooms, and seventeen papers were included in the framework development stage. The Feedback Framework comprised 3 main categories (Audit, Feedback, and Goal-Setting) and 22 subcategories. The review highlighted the limited empirical research focussing solely on feedback for ECPs, which was surprising given the particular nuances to feedback for ECPs identified through this study.

Discussion: We offer the Feedback Framework to optimise the design of future feedback interventions for Early Career Professionals and encourage future feedback research to move away from generic models and tailor their work to specific target audiences.

Introduction: Word count (main manuscript): 5,394

Meta-analyses in education have shown that feedback can be a powerful intervention to increase learning and performance (1). In primary and secondary education, feedback has been identified as one of the most impactful education interventions, resulting in an average learning gain of 8 months in every year (2). The importance of feedback has also been recognised in healthcare and healthcare education, with audit and feedback generally leading to small but potentially important improvements in professional practice (3, 4). Feedback in both education and healthcare, however, shows significant variability in impact, with some interventions having no impact, or even negative impact (4, 5). In other words, whilst feedback can be powerful and effective in certain circumstances, the outcomes are inconsistent. This is perhaps not surprising, given the large number of behaviours and settings to which feedback interventions have been applied and the multiple components of feedback that may be altered.

Research exploring the different components of feedback which contribute to effectiveness also faces challenges. The latest Cochrane systematic review on audit and feedback, undertaken by the Effective Practice and Organisation of Care (EPOC) group (3) synthesised best estimates of effect sizes according to different components of feedback interventions and concluded that feedback may be most effective when health professionals are not performing well to start out with; when the person responsible for the audit and feedback is a supervisor or colleague; when feedback is provided more than once; when feedback is given verbally and in writing; and when it includes clear targets and an action plan. In 2014, Ivers et al. (4) extended this Cochrane review and a cumulative analysis showed that the effect size became stable in 2003, suggesting that new trials are adding little to the question of whether feedback interventions are effective. As they put it: *"At this point the appropriate question is not 'can audit and feedback improve professional practice' but 'how can the effect of audit and*

feedback interventions be optimised?" (p1538). They conclude that research is now needed to understand the impact of task characteristics, feedback characteristics, recipient characteristics and context on feedback effectiveness (4). From a complex systems perspective (6), these different characteristics are also likely to interact in unforeseen ways, so rich descriptions of the feedback process and its impact (or lack of impact) will be needed. Whereas, the Cochrane reviews have only included RCTs, other types of study designs and theoretical perspectives are now required to explore the professional or organisational processes that may impact substantially on effectiveness and provide greater insights into mechanisms and unintended consequences.

Colquhoun et al. (7) argue that part of the problem is that interventions have typically been designed without underpinning theory from the behavioural and social sciences. This is problematic because theory provides important insights into how change strategies might work and when and why they might not work. Colquhoun et al. (7) analysed randomised controlled trials of audit and feedback and concluded that explicit use of theory in these studies was rare. Colquhoun et al. (8) developed a list of theory-informed hypotheses, based on interviews with theory experts, about how to design more effective audit and feedback interventions. This can inform practical guidance to support those designing feedback interventions (9).

Early career professionals (ECPs), who are transitioning into busy work environments, are a particularly important group of learners. It is increasingly clear that the experiences and needs of those at the beginning of their careers are different from experienced professionals, for example because they may be unfamiliar with the workplace systems and professional norms and may be working within a strong professional hierarchy (10). To date, there is little research that targets early career professionals specifically and we need to know much more

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about how the type of feedback received, intentionally or unintentionally, affects the learning or sense of professional identity of qualified professionals entering the workplace (11). Since feedback is often more effective when baseline performance is low (3), it is likely that the 'return on investment' from a feedback intervention in terms of impact on professional practice would be high as ECPs learn to undertake the tasks required by their new jobs. In addition, retention of early career professionals is problematic in medicine, teaching and beyond, suggesting that additional opportunities to provide support and encouragement are needed. The transition from university to work is challenging in any field but may be particularly daunting in busy environments such as hospital wards and school classrooms, which are what Eraut (12) calls "hot action" contexts where "changing conditions feature prominently" (p258).

Therefore the aim of this scoping review was to bring together information in an easily accessible way to support the optimal design, implementation and reporting of workplace-based feedback interventions for early career professionals. This complements previous research, such as Van der Ridder et al. (13) whose work focusses on undergraduate education and assessments (rather than early career professionals in busy workplace environments and naturally occurring workplace-based measures); and whose primary audience is researchers (rather than feedback intervention designers). Given the complexity of feedback interventions and their variable reported impact, our methodological approach sought to identify literature that provided in-depth accounts of feedback strategies that aimed to change the behaviour of early career professionals, from research involving a wide range of study designs and from different professions. We then developed a Feedback Framework which can be used to optimise the design of future interventions and developed a theory of feedback that was broad enough to accommodate what we had learned about early career professionals.

Methods:

Aim / Research Questions:

The aim of this literature review was to bring together information which can support the optimal design, implementation and reporting of workplace-based feedback interventions for early career professionals (as defined in Table 1).

The research questions were:

- What features of workplace-based feedback interventions are important in changing early career professional behaviours and/or improving workplace outcomes?
- Why are these features important and how might they work for early career professionals?
- Under what specific circumstances are these features potentially most beneficial?

Informed by Arksey and O'Malley's methodological framework, we conducted a scoping review to characterise published research literature relating to a given topic (14, 15). We considered a number of educational, psychological and socio-cultural theories to inform our study but ultimately selected Feedback Intervention Theory from organisational and management research, and used their definition of feedback as our starting point (5).

Feedback Intervention Theory has five basic arguments: behaviour is regulated by comparisons of feedback to goals or standards; goals or standards are organised hierarchically; attention is limited and therefore only feedback-standard gaps that receive attention actively participate in behaviour regulation; attention is normally directed to a moderate level of the hierarchy; and feedback interventions change the locus of attention and therefore may affect behaviour.

Definitions

- Feedback: for the purposes of this study, we see feedback as an intervention comprising those “actions taken by (an) external agent(s) to provide information regarding some aspect(s) of one’s task performance” (5). Our focus was feedback from workplace measures that related to specific element(s) of authentic practice and which targeted learner behaviours relevant to professional practice and/or clinical workplace outcomes. Assessment feedback was out of scope, unless it met these specific criteria. Feedback on simulated activities was out of scope.
- Workplace settings: this study was interested only in feedback within authentic, busy workplaces settings comparable to a ‘hot action’ context (12), such as hospital wards or school classrooms.
- Early Career Professional: a graduate who is less than two years into professional practice.

Developing the search to identify studies

Search terms were identified through background searching in Google and relevant journals, and specificity and sensitivity of free-text (i.e. title and abstract), and indexing (e.g. MeSH) terms explored using Ovid MEDLINE. Combinations of search terms were benchmarked against pre-specified target papers. Our final approach combined terms for ‘feedback’ and terms which described either the effectiveness of feedback or terms which are used in qualitative study designs such as ‘qualitative’, ‘experience’ and ‘interview’ (16). The qualitative study design terminology recognised that many of the papers from our pilot searches that were providing the most detailed information in relation to the Research Questions were qualitative. However, we did not wish to exclude other study designs, hence these terms were combined using OR with terms which described the effectiveness of feedback which are not specifically related to a particular study type. Given the study’s resource constraints, we used

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a date limit of 1990 onwards, selected since it encompassed many key professional education developments, and an English language filter.

Search strategy

The databases searched (Box 1) were selected to provide coverage of medicine, health care more broadly, education, and other professions. The Ovid MEDLINE search strategy is presented in Figure 1. The search results were supplemented by checking the reference lists of the studies included in the synthesis stage of the review.

Mapping stage

The aim of the mapping stage was to describe the inevitably broad and diverse literature, in order to make an informed decision about which studies would contribute substantially to the framework development stage (17). The inclusion criteria for both stages are described in Table 1. For the mapping stage, the first 10% of the titles and abstracts were assessed independently and then compared by two review authors (KM and MP). Any differences in opinion were resolved through discussion, with a third author resolving disagreements. The remaining title and abstracts (90%) were assessed by KM. Any uncertainties were discussed by KM and MP and, where necessary, all authors. The reasons for excluding papers are given in Figure 2. Endnote was used to manage the screening stage.

The 92 studies included at this stage were read in full by one of three authors (NB, CP, KM) to assess whether the article still met the inclusion criteria having read the full text, with all papers recommended for exclusion referred to another author (MP), and all authors reviewing these decisions to ensure consistency of approach. Data extraction categories were informed by the template for intervention description and replication (TIDieR) checklist and guide (21) because this articulated the kinds of information required to describe feedback interventions. Data were extracted by one author and verified by a second, using a standardised form in

Microsoft Word. Since the aim of the mapping stage was to characterise existing literature on a particular topic in order to make an informed decision about whether to undertake in-depth review and synthesis, we did not undertake quality assessment at this stage.

Framework development stage

A subset of the included papers were selected based on specific inclusion criteria (see Table 1) to be subjected to a second phase of data analysis called framework development. All selection decisions were made by three authors (KM, CP, NB) and papers were not excluded based on study design. Our approach to drawing the literature together to create a framework was 'configuring' rather than 'aggregating' (17). So rather than focussing on '*multiple observations of the same phenomena*' (p87), the aim of this stage was to place '*study findings alongside one another in order to build up a picture of the whole, and how they relate to one another*' (p88), which is more achievable for diverse literatures. To 'configure' our studies, we drew on the principles of thematic synthesis.

Thematic synthesis

We read each study line-by line, made notes, charted key observations and revisited the text to extract the key ideas, concepts and messages. In doing so, we focussed as much on author explanations for the observed findings as the findings themselves. We went through each paper highlighting the sections that contribute to the research questions and making comments/codes about how they do that, which we then discussed and combined, ultimately leading to a Feedback Framework. The process was not entirely inductive as it was driven by the research questions and Feedback Intervention Theory, and involved a wide range of study designs.

Quality assessment

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Scoping reviews are not required to undertake quality appraisal (14). Thus, while we did not exclude any papers on the basis of quality (since there is little empirical basis on which to do this), we did interpret and make sense of the different aspects that these papers presented throughout the analysis process, taking into account the paradigm they belonged to, how well each of their arguments were made on the basis of data and how the different papers corroborated each other. This was carried out predominantly by one author (KM), with input from three further authors (NB, CP, MP). We have made this process transparent in Table 5, which contains a column for 'strength of evidence'.

Results

Papers identified

The total number of hits retrieved from each database search is detailed in Table 2 and a flow diagram showing which papers were included is given in Figure 2. Through searching the reference lists of the included studies, 57 additional references were identified as potentially interesting, of which 24 had already been identified by our database search. Of the remaining 33, 21 did not meet our inclusion criteria, 4 were duplicates and 1 (an earlier version of a Cochrane review) had been withdrawn, leaving 7 papers (2 empirical, 5 literature reviews) that were read in full and included in the mapping stage. A subset of 17 of the papers from the mapping stage were included in the framework development stage.

Mapping the literature

In total, 80 studies were included in the mapping stage. Of these, 60 were empirical studies (more details about the studies are presented in Table 3). Six were published between 1990 and 1999; 20 were published 2000-2009; and 34 were published in 2010 or beyond. The USA published the vast majority of the included empirical studies (41 papers). In terms of study design, 49/60 were quantitative non-randomised, 6 were quantitative randomised, 4 were

mixed methods and one was qualitative. The numbers of participants receiving feedback in these studies was often unclear but varied from 1 to 180 participants. In terms of settings, 36 involved hospitals and 24 involved schools. In general, the participant numbers were greater in hospital settings, with smaller numbers in the studies involving schools. Only 18 / 60 empirical studies focussed specifically on early career professionals. There were also 20 literature reviews included in the mapping stage (Table 4). Of these, 3 were published 1990-1999, 8 were published 2000-2009 and 9 were published in 2010 or more recently. Most were from studies in healthcare settings (17), with only 2 from schools and 1 was a theoretical paper that was not context-specific. The number of included studies varied from 7 to 140. The literature reviews generally focussed on quantifying the effectiveness of feedback rather than optimising the process.

Developing the Feedback Framework

We reviewed 17 papers in the framework development stage (11 empirical studies – 6 quantitative, 4 mixed, 1 qualitative – and 6 literature reviews). This subset was narrower in scope, with over half the papers focussing specifically on ECPs (9/17), most coming from a healthcare context (14/17) and all providing in-depth analysis of contextual features. The included papers did not contain an existing feedback taxonomy or framework that was broad enough to accommodate the literature found. We therefore created one through this research (Table 5) and used it to organise the findings. The Feedback Framework incorporated the findings of the included papers to conceptualise workplace-based feedback interventions as comprising 3 main categories (Audit, Feedback, and Goal-Setting), with 22 subcategories. The categories and sub-categories are summarised in Table 5, with an indication of the strength of the evidence underpinning each subcategory, so that researchers can target their future work on aspects that have less robust evidence.

Overall, there appeared to be a lack of clarity and consistency in the use of terminology in the included studies, combined with a lack of specificity in discussing the different components of 'feedback'. The Effective Practice and Organisation of Care (EPOC) group who undertook the most recent Cochrane review of audit and feedback (3) say *"In an audit and feedback process, an individual's professional practice or performance is measured and then compared to professional standards or targets. In other words, their professional performance is "audited". The results of this comparison are then fed back to the individual. The aim of this process is to encourage the individual to follow professional standards"*. However we feel this definition seems to conflate the process of feeding back the data collected through the audit and the process of reflecting on the data and setting goals and an action plan to bring about a change in performance, even though this latter aspect was deemed important in its own right within the papers we reviewed. We also recognise that the observed performance is underpinned by complex clinical reasoning. In addition, the definition promotes the following of professional standards, whereas a critical role for a professional might be to decide when it is not appropriate to follow the guidance. Similarly, Kluger and DeNisi (5) consider inter-personal issues to be separate to feedback whereas other research suggests interprofessional issues are core. To improve transparency of feedback interventions, Ivers et al. (4) called for better reporting but, although the number of papers was limited, we did not see a marked improvement in reporting in the most recently published papers.

Table 5 outlines the three main categories of the Feedback Framework we have developed (Audit, Feedback, Goal-setting), each with sub-categories. It presents a synthesis of knowledge from the included papers and indicates the strength of the evidence. Here we provide a brief overview of the three categories.

Audit in this context relates to the collection of data regarding some aspect of one's task performance. The Oxford Dictionaries defines audit as "A systematic review or assessment of something" (<https://en.oxforddictionaries.com/definition/audit>). Other authors have referred to 'performance measurement' instead (Redwood et al. 2013) or have only referred to audit implicitly (5). In the audit category, the 6 subcategories developed from analysis of our data were: complexity of task chosen; type of task chosen; nature of data to be collected; metric importance to the intended recipient; data credibility; and baseline performance (Table 5). According to the literature reviewed, less complex tasks or behaviours are probably easier to change through feedback. Where feedback metrics were aligned to the priorities of the recipient and/or organisation, they seemed likely to have greater impact, although feedback messages could be undermined by contextual cues or other feedback sources. Feedback seemed most effective when baseline performance was low, which is likely for ECPs, but if it was very low then rapid improvement might be needed to sustain engagement with the task. Importantly, for ECPs who often work under supervision, or where teamwork or shift work is common, performance data were sometimes deemed an unfair reflection of ECP's own clinical practice, which could undermine the feedback process (e.g. *'Junior doctors explained that because they rarely made prescribing decisions independently, the feedback letters should be sent to all team members, including the senior doctors.'*) (30 p. 587).

In the methods section, we defined feedback as *'actions taken by (an) external agent(s) to provide information regarding some aspect(s) of one's task performance'* (5); in other words, the way in which audit data are made available to the feedback recipient. Information may be provided via a range of means and can be presented in a range of ways, for example with or without comparisons to other data. In the category of feedback intervention, the 7 subcategories were: feedback format; comparison to other data; judgment made on data; content of feedback; likelihood of feedback to be perceived as a threat; correct solution

information; and timing and frequency of feedback (Table 5). Written feedback seemed more effective than verbal or graphical delivery. Comparison to past performance (e.g. feedback on progress over time) tended to be effective, since it directed attention to the task, whereas public feedback, peer comparisons, praise and discouragement could divert attention to meta-task aspects involving the self (e.g. emotional responses, concerns about implications). Clay et al. propose debriefing cards as '*a tool for deliberate practice*' improving trainee performance by providing '*the opportunity for frequent self-assessment, explicit expectations for performance, and feedback on each resident's self-assessment by a supervising physician*' (11 p743). Feedback could sometimes be perceived as a threat to self-esteem or to external rewards/punishments, so the benefits of 'authoritative' sources must be weighed up against the risks of this making the feedback seem more threatening. Providing a 'correct solution' as part of feedback was thought to increase its likely impact by focussing attention on target behaviour but correct solutions may be scarce within professional practice, where complex judgments in a messy practice context are common. Feedback was thought to be most effective when presented more than once and when it occurred soon after the performance event.

Goal-setting, the final category in our Feedback Framework, occurs when the feedback recipient considers behavioural change based on the information received. Providing information, alone, is often insufficient to change behaviour or outcomes. In this category, the 9 subcategories were: presence or absence of goal-setting; presence of a reviewer to support goal-setting; relationship to reviewer; nature of goal; tailoring of goal setting conversation; nature of conversation; recipient ownership of goal setting; acceptance of goals suggested; and successful completion of goals (Table 5). Knowing what to do with feedback seemed as important as receiving it. The included studies suggested that feedback was more effective when combined with reflection and/or goals and an action plan. Most included studies

involved a reviewer in goal-setting, who needed to be perceived as credible. A quality goal-setting conversation could help learners to identify the gap between current and desired performance and agree a strategy for change. Goals seemed unlikely to be accepted or prioritised if the immediate relevance to practice setting was unclear. As Redwood et al. note '*...metrics used need to be concrete rather than abstract and must reflect actual work processes which may be different in different clinical contexts (e.g. working on a day or night shift, or in a surgical or medical speciality).*' (27 p. 9). Goals also needed to be within the scope of responsibility or possibility of the ECP. It seemed important for recipients to discuss the performance context, since sometimes apparent 'poor performance' could be explained when placed in context.

Modified Feedback Intervention Theory for ECPs

A key question underpinning our research was the extent to which ECPs were a specific group, with different needs and contextual influences than other professional groups. Therefore Table 6 outlines some key features of Feedback Intervention Theory (5), which in its original form was offered as a universal model, and highlights where our research indicates that it might need to be extended or given extra weighting to accommodate the particular situation of feedback for ECPs in busy work environments.

Discussion

The aim of this scoping review was to bring together information which can support the optimal design of workplace-based feedback interventions for early career professionals. We mapped the literature that exists already and organised the most relevant literature into a Feedback Framework (Table 5), developed for this study, which we now offer as a tool to optimise the design of future feedback interventions. The detailed analysis allowed us to answer the research questions by identifying the specific features of feedback interventions for ECPs that seemed to underpin their effectiveness (or ineffectiveness) and by trying to

explain why these features were important and how they might work (Table 5). We addressed the final research question by exploring the extent to which Feedback Intervention Theory in its existing format could accommodate ECPs, which led us to identify some specific nuances associated with ECPs that we felt needed modification, or greater emphasis, in a "FIT for ECPs" (Table 6).

It is clear that feedback interventions have the potential for significant positive impact and that ECPs are an appropriate target group who may stand to gain the most benefit from feedback. However, our review suggests that few studies provided a convincing rationale that their feedback intervention design was optimal, and very few focussed on ECPs alone, so we believe it is likely that the impact of current and future interventions can be significantly improved. Our analysis of findings against the existing Feedback Intervention Theory suggests that it would need to be modified in order to take account of the key features influencing feedback for ECPs. Colquhoun et al. (8) suggested that a taxonomy of feedback interventions would improve the design, description and reporting of feedback interventions and we hope our Feedback Framework might contribute towards this aim.

Like previous researchers (3, 5, 18-20), we note a need for more detailed reporting of feedback interventions, with rich descriptions of the different components and rationale for their combination, in order to share experiences, build theory or synthesise evidence across studies. Although these are challenges in many domains, it is particularly important for complex, multistage interventions such as feedback. In healthcare the terminology 'audit and feedback' seems to have become established in the literature but seems to underplay the important steps that occur after feedback is received and before behaviour change occurs, which are highlighted through our included papers and other literature (22-24). The literature reviews included in our scoping review typically only synthesised quantitative studies (19) and

often only RCTs (3, 4, 18, 25). A broader range of empirical research methodologies would provide greater insights into mechanisms and unintended consequences, and different types of literature review such as qualitative metasyntheses, realist reviews, or other theory-based approaches to evidence syntheses (26). A stronger theoretical basis is also needed.

Colquhoun et al. (8) developed a list of testable theory-informed hypotheses about feedback, which sets out a useful research agenda and makes a first step in linking theory to practice, but evidence syntheses and frameworks are now required to inform the design of feedback interventions for specific recipient groups, since the primary data is challenging and time-consuming to interpret (18).

Recommendations for policy and practice

Based on the literature included in this study we recommend that: feedback interventions focus on an important aspect of performance; the data selected are credible and reflective of individual performance of the target audience, in our case ECPs; information should be communicated privately and mapped against appropriate external standards (relevant to stage of training) with clear information about the standard sought; supportive, developmental opportunities to discuss feedback and set goals are provided with an experienced professional who is familiar with the specific practice context and has good facilitation skills; and that the goals are within the ECP's scope of practice. However it is hard to predict effectiveness of feedback interventions (27-30), since subtle changes of context or process can make a big difference (31) and subtle nuances can affect how the feedback message is received (31).

The Feedback Framework developed through this research is offered to support the design (or re-design) of feedback interventions for ECPs. Through Table 5, we have highlighted the strength of the evidence base underpinning each stage of the Feedback Framework, using a format applied successfully for communicating with policy makers and education professionals

(2). Table 5 also signposts the original publications underpinning each summary judgment, so that feedback intervention designers can engage with the evidence first-hand should they wish to. We hope that providing easy access to the theory and evidence underpinning each stage of the Feedback Framework will enable future interventions to be more likely to have a greater impact.

Recommendations for future research

The Feedback Framework also serves to highlight those aspects of feedback which have received a lot of attention by researchers and those which have been neglected to date. By mapping which aspects of the framework are well populated with research, we hope to be able to ensure that research efforts are channelled to those areas most neglected currently and do not waste resources duplicating what is already well established in the literature (4). Topics requiring future attention include the impact of the types and complexities of tasks chosen for a feedback intervention, perceptions of feedback recipients about the nature of the data chosen for feedback, the impact of praise or displeasure on the feedback recipient, and the process and implications of the goal-setting conversation (Table 5). For example it would be interesting to understand how highly experienced mentors, or those who know the individual feedback recipient, implicitly tailor their feedback. But most importantly, we encourage future feedback research to move away from generic models and tailor their work to the specific target groups targeted by feedback interventions.

Like Hysong 2009 (18), we felt Feedback Intervention Theory provided a useful theoretical framework to guide decisions in designing future feedback interventions. Despite offering a very interesting perspective on feedback, it was cited by very few of the studies included in our scoping review. We recommend that Feedback Intervention Theory or modifications thereof,

as well as other behavioural and social sciences theories, are given greater attention in future research.

Interestingly, in some of the studies included in the synthesis stage, the feedback intervention did not work as anticipated (27, 29). As with all complex interventions, we need to be alert to unintended consequences and see these as important opportunities for learning. Studies involving observation may provide new insights to workplace contexts in which unanticipated events have occurred. Other future studies might interview multiple stakeholders in feedback interventions that have worked particularly well or particularly badly, to try and identify common themes. The future is also likely to involve easier access to electronic performance data, which will provide new opportunities to evaluate feedback interventions (32), although concerns have been raised about the panoptic gaze on clinical practice (27).

Strengths and limitations of the research

The strengths of this work are the rigorous two-stage scoping review process undertaken by a multidisciplinary team; the deliberately broad methodology to incorporate relevant literature beyond the healthcare setting; the focus on busy workplaces and naturally occurring measures; and the inclusion of a wide range of study designs. Our team included an information scientist, implementation scientist and social scientist as well as medical educators. Our review allowed a comparison of literature across two key 'hot action' environments: hospital wards and school classrooms, since similar numbers of empirical studies were included in the mapping stage. In general, the number of participants was smaller for school settings in the included papers and there were fewer literature reviews.

As with all research studies, there are also some limitations. The summary of evidence derived from a scoping review can only be as good as the literature it finds. Resource constraints

meant we only looked at literature since 1990 and published in English language. The fact that feedback intervention reports were mostly positive raises concerns about both publication bias (in that unsuccessful or negative impact feedback interventions may not be published (19)) and selection bias (in that the research participants who engage with feedback may reflect those more motivated trainees (33)). We believe studies that don't work as intended or participants who aren't keen to participate are well placed to contribute important new insights. Also, given the limitations of reporting and methodologies described, we are unlikely to know whether feedback interventions took place as intended (29) and not all the included literature focussed solely on ECPs. More mixed methods research, for example incorporating a qualitative process evaluation, would help with this. As McLellan et al. put it, *'the social world is a complex one and we would not therefore be able to explain how or why our intervention had an effect on the basis of numeric data alone'* (28). Finally, our search does not claim to be exhaustive and the Feedback Framework developed is just one interpretation, but we hope it can start an interesting and important conversation about workplace-based feedback in ECPs.

Conclusions

The aim of this scoping review was to bring together information which can support the optimal design of workplace-based feedback interventions for ECPs. The Feedback Framework we developed comprised 3 main categories (Audit, Feedback, and Goal-Setting) and 22 subcategories. The evidence summary highlighted imprecise terminology; patchy research coverage across the Feedback Framework; and limited research focussing on ECPs. Comparing our findings with the existing Feedback Intervention Theory allowed the specific nuances associated with feedback for ECPs to be made explicit. We now offer the Feedback Framework and our tailoring of FIT for ECPs to help optimise the design of future feedback interventions; and to help researchers identify priorities for study.

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Box 1: Databases searched

- MEDLINE, via Ovid
- MEDLINE-in-Process, via Ovid
- PsycINFO, via Ovid
- CINAHL, via EBSCO
- Education Research Complete, via EBSCO
- ERIC (which covers education), via EBSCO
- Cochrane Database of Systematic Reviews, via the Cochrane Library
- Social Science Citation Index (which covers sociology, business & communication, law and nursing), via Thomson Reuters
- ASSIA (which covers nursing, mental health and other health services from a social science perspective), via ProQuest

Table 1: Inclusion criteria

Stage	Category	Descriptor
Mapping & framework development	Empirical research	Articles that presented empirical research. Literature reviews were only included if they had a clear and transparent methodology. Articles were excluded if the abstract said nothing about data collection, analysis or findings; or presented a collection of papers or a book; or were primarily a description of an initiative or intervention with no evidence of impact.
Mapping & framework development	Feedback to early career professional (ECP)	Articles that described feedback interventions from an external source (e.g. senior, peer, patient) to an individual ECP. Articles were included if ECPs formed (or were likely to form) a substantial proportion of the study population. For example, specialist trainees in medicine in the UK were excluded since they were more than two years postgraduate but participants referred to as junior doctors, house officers or residents were included unless it was clear that they were >2 years post-graduation. Articles were excluded if they focussed on feedback to teams rather than individuals; focussed on feedback to managers about ECPs; focussed on self-assessment, feedback to self or self-monitoring; focussed on ECPs giving feedback to others; or focussed on feedback to paraprofessionals.
Mapping & framework development	Authentic 'hot action' workplace	Articles that involved feedback interventions in authentic workplace settings, which are comparable to a 'hot action' context (12). Articles were excluded if they involved simulated practice; involved community-based practice only e.g. general medical and dental practice, outpatient clinics, pre-school teaching, kindergarten teaching; involved abstracted, general or 'overall performance' feedback rather than specific feedback relating to a discrete element of authentic practice; involved feedback that was not given in the setting where the work takes place (or close by) or by those who would have close insights into the setting. Articles involving feedback in verbal, written and electronic form were included.
Mapping & framework development	Learner behaviour	Articles that described feedback interventions that aimed to impact on learner behaviours relevant to professional practice and/or clinical workplace outcomes. Articles were excluded if they focussed on satisfaction, knowledge, skills, or attendance at work only; or focussed on the perceptions of ECPs without offering a perspective on behaviour change or workplace results.
Mapping & framework development	Impact of feedback	Articles that focussed on the impact of the feedback intervention rather than other aspects. For example, articles that focussed on the feedback tool itself (e.g. reliability, validity, implementation) were excluded.
Mapping & framework development	Relevant to Research Questions	Articles that presented findings that had the potential to contribute to this study's Research Questions.
Framework development	Detailed focus on feedback	Articles whose major focus was the feedback process, especially in relation to ECPs, and would therefore contribute substantially to framework development

Framework development	Rich contextual detail	Articles that had rich contextual details that enabled an understanding of the important influences affecting feedback to ECPs, and would therefore contribute substantially to framework development
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Table 2: Total number of records and unique records

Database	Number of hits
MEDLINE	1607
MEDLINE-in-Process	181
PsycINFO	2422
CINAHL	801
Cochrane Database of Systematic Reviews	0
Social Science Citation Index	1363
ASSIA	265
ERIC	988
Education Research Complete	1049
Total number of records	8676
Duplicate records	3629
Total number of unique records	5047

Table 3: Empirical studies included in our literature review

First author	Year	Study design (as per McGill)	Participant numbers (feedback recipients)	Country	Setting	Aim	Brief description	Feedback recipient	Feedback provider	Feedback frequency	Include in second stage?
Abu-Hanna (40)	2010	Quantitative non-randomised : <i>before and after study</i>	Unclear (ward-round team)	Netherlands	Hospital: one Intensive Care Unit	To examine the impact of providing feedback at ward rounds on adherence to a local mechanical ventilation policy.	Feedback about adherence to the guideline provided at daily ward rounds using a bedside computerized decision support system. The outcome measure was the percentage of ventilation time in excess of the guideline's recommendation and actual usage of the feedback.	ICU physicians and residents	Computerized decision support system	Daily	No
Alagha (41)	2011	Quantitative non-randomised	Unclear (focus is prescriptions written and number of patients)	Egypt	Hospital: one paediatric Intensive Care Unit	To investigate the impact of different measures, implemented by clinical pharmacists, on prescribing error rates.	Provided information. Changed drug chart structure. Introduced orientation for new residents. Gave residents feedback on errors via individualized written reports.	Residents (junior doctors)	Clinical pharmacist (in writing).	Throughout postintervention period	No
Baysari (30)	2013	Mixed methods	36 prescribers	Australia	Teaching hospital	To determine whether providing individualised feedback to doctors about their recent compliance with the hospital's antibiotic policy improves compliance with the policy.	Audited to see where 'controlled' antimicrobial prescribed without approval. Feedback letter sent to named prescribers each week.	Junior doctors 1-9 years into training	Professor of Clinical Pharmacology via email	7/36 received multiple letters	Yes
Boekeloo (31)	1990	Quantitative randomised controlled:	29 internal medicine interns	USA	Hospital: inpatient internal medicine service	To improve house staff management of cholesterol with inpatients.	Checklist. Performance feedback summarised intern's cholesterol management performance compared with most up-to-date recommendations.	Interns	Specialist in Preventative Cardiology	Multiple times	Yes

		<i>at individual level</i>									
Briere (42) (thesis)	2012	Same study as Briere 2015									No
Briere (43) (publication)	2015	Quantitative non-randomised	3	USA	Elementary school	To investigate effects of a within-school consultation intervention provided by veteran teachers, involving self-management, structured meetings, focused performance feedback.	Used a self-monitoring strategy. Consultation meetings involved data review, performance feedback, and goal setting.	New teachers with low rates of praise feedback.	Veteran teachers	Weekly for at least six weeks	No
Brinkman (32)	2007	Quantitative randomised controlled: <i>at individual level</i>	36	USA	Children's hospital	To test whether multisource feedback, including self-coaching, improves resident communication skills and professionalism.	Self-assessment. Feedback report about baseline parent and nurse evaluations. Tailored coaching session.	First year paediatric residents	Nurses and parents	Once	Yes
Brock (44)	2002	Quantitative randomised controlled: <i>at group level</i>	92 healthcare workers	USA	Trauma centre: ER and ICU	To determine if participation in performance feedback would result in a statistically significant improvement in handwashing behaviours.	Observed for handwashing behaviours. Performance feedback via personal confidential card identifying rate of handwashing and handwashing technique.	Healthcare workers	Researcher via confidential written card	One off feedback, based on observation of multiple HW events.	No
Chern (45)	2005	Quantitative non-randomised	Unclear	Taiwan	Hospital: emergency department	To evaluate what effects a quality improvement initiative with feedback from telephone follow-up and teaching would have on adverse outcomes.	Direct feedback on patient outcomes via one-to-one conversation within 2 days. Action planning.	Treating clinician	Faculty investigator	Unclear but presumably could receive feedback more than once.	No
Clay (33)	2007	Quantitative randomised controlled:	18	USA	Hospital: medical ICU	To develop an assessment tool for bedside teaching in the intensive care unit (ICU) that provides feedback to residents	Residents were evaluated by nurse, fellows, and faculty.	Residents	Fellows	Multiple	Yes

		<i>at rotation level</i>				about their performance compared with clinical best practices.					
Codding (46)	2005	Quantitative non-randomised	5	USA	Private school: students with acquired brain injury	To evaluate the effects of performance feedback on the percentage of antecedent and consequence components implemented correctly during 1-hr observation sessions.	Proportion of correct implementation of student's behaviour support plans calculated. Performance feedback given.	Special needs teachers	Investigator	Multiple	No
Colvin (47)	2009	Quantitative non-randomised	1	USA	Suburban high school	To explore the relevance and effectiveness of classroom observation and performance feedback that focused on the relations among classroom instructional settings, instructional practice, and classroom student behaviour.	Observations of classroom teaching. Summary tables of teaching and student behaviours. Teacher and observer analysed data and developed an action plan.	Teacher	Investigator	Three times	No
Cuticelli (48)	2016	Quantitative non-randomised	6	USA	Public school	To explore whether providing teachers with performance feedback can improve quality of instruction by increasing the numbers of Opportunities To Respond delivered during Tier 1 reading instruction.	Teacher observations. Number of opportunities to respond were counted. Performance feedback with teachers provided with graphic and oral feedback.	Teachers: 3 kindergarten, 3 first-grade.	Doctoral students (educational psychology)	Multiple	No
DiGennaro (49)	2007	Quantitative non-randomised	4	USA	School for students with brain injuries	To examine the extent to which treatment integrity of 4 teachers was affected by goal setting, performance feedback regarding student or teacher performance, and a meeting cancellation contingency.	Teacher training to address student problem behaviour. Goal setting for student behaviour, with daily written feedback on student performance and/or their accuracy in implementing intervention.	Struggling special education teachers	Education consultant	Multiple (daily)	No
Digennaro-Reed (50)	2010	Quantitative non-randomised	3	USA	School for students with	To examine the effects of individualized video modelling on the accurate	Participants viewed individualized instructional video of experienced teacher demonstrating	Special needs teachers	Experimenter	Multiple	No

					developmental disorders	implementation of behavioural interventions.	accurate implementation. Performance feedback prior to the video.				
Duncan (51)	2013	Quantitative non-randomised	3	USA	Public schools: general education	To examine effects of generalization training with goal setting and a feedback note on teachers' specific labelled praise (SLP) toward target and nontarget students.	Teacher instruction, role playing, practice, and feedback. Goal setting for delivery of SLP to the target student. Performance feedback relating to goal. Training to generalise intervention.	Teachers	Doctoral student in school psychology	Multiple via feedback note	No
Eveillard (52)	2011	Quantitative non-randomised	75	France	Healthcare: four settings (acute-care geriatric wards, skilled nursing homes, physical rehabilitation units)	To assess the impact of a multi-faceted training program on the compliance with hand hygiene and gloving practices.	Intervention program including performance feedback, three training sessions, assessment of hand hygiene performance.	Healthcare worker	Researchers	One off	No
Fakih (53)	2012	Quantitative randomised controlled: at unit level	180 nurses	USA	Teaching hospital: 10 adult wards	To evaluate effect of education and feedback on Peripheral Venous Catheter care and infectious complications over a 3 month intervention.	Education, educational materials (posters and cards), performance feedback, twice-monthly audits, monthly reports to nurse managers	Nurses	Research nurses	Twice-monthly audits	No
Feely (54)	1990	Quantitative non-randomised	Unclear (focus on events rather than people)	Ireland	Hospital	The effects of introducing a hospital formulary alone and with active intervention were compared prospectively with regard to drug costs and the quality of prescribing.	Feedback on prescribing habits. Peer comparison. Information on drugs.	Prescribers and senior consultants	Unclear	Multiple	No
Frenzel (55)	2010	Quantitative non-randomised	Unclear (23,279 anaesthetic events)	USA	Hospital: cancer centre	To compare effects of continuing medical education alone, with one off feedback, and with ongoing feedback on postoperative nausea and vomiting prophylaxis guideline compliance.	Analysed guideline compliance of 23,279 anaesthetics. Individual performance feedback compared to peers.	Individual clinicians	Researcher, via confidential individual reports.	Once in one condition; multiple times in another.	No

Fuller (56)	2012	Quantitative randomised controlled: <i>stepped wedge cluster RCT</i>	Unclear (33 wards in 16 hospitals)	UK	Hospitals: 33 wards	To determine the effectiveness of a feedback intervention to improve hand-hygiene compliance.	Repeating 4 week cycle (20 minutes per week) of observation, feedback and personalised action planning, recorded on forms. Observed impact on hand hygiene compliance.	Healthcare workers including nurses and doctors.	An allocated "ward coordinator", a junior ward sister or infection control link nurse.	Multiple	Yes
Fung (57)	1997	Quantitative non-randomised	16	Canada	Hospital: Department of Obstetrics & Gynaecology	To describe initial experience with a computerized telecommunication system to record resident performance of laparoscopic surgery.	After a laparoscopic procedure, surgeon and resident telephone a toll-free number, respond to pre-recorded statements using a Likert scale and comment on response to events during the surgery. Feedback made available to residents.	Residents	Surgeons	Multiple	No
Garritty (58)	2008	Quantitative non-randomised	8	USA	School for children with developmental disabilities	To evaluate a supervisory intervention to increase the frequency of inter-observer agreement assessments performed by educational staff.	Intervention components included action directives, strategic posting of inter-observer agreement recording forms, and performance feedback (positive reinforcement and correction).	Teachers	Supervisors	Every week	No
Gilbertson (59)	2007	Quantitative non-randomised	5	USA	Elementary school: 5 general education classrooms	To examine the integrity of teachers' implementation of a peer tutoring intervention for five students referred for consultation and intervention due to academic concerns.	Intervention comprised: verbal training, faded 3-criteria classroom training, and response-dependent performance feedback.	Teachers	Consultant	Multiple - any time <100% compliance	No
Gordon (60)	2012	Quantitative non-randomised	26	UK	Hospital: 1 inpatient paediatric unit	To explore the introduction of a departmental prescribing feedback system designed to provide contemporaneous prescribing feedback within the context of shift working on prescribing errors and safety attitudes.	Intervention comprised 3 weekly assessments of prescribing errors over a 3 month period; followed by feedback via a poster and emails to staff, giving general and anonymous personalised feedback.	Prescribers (paediatric medical staff)	Unclear	Multiple	Yes

Hagermoser (61)	2013	Quantitative non-randomised	5	USA (NE)	Middle school (grades 6–8)	To explore whether performance feedback effectively increases teachers' treatment integrity when implementing a classwide, team-based contingency management intervention.	Training, then no performance feedback phase, followed by a performance feedback phase as needed.	Teachers	Internal Consultants (school social worker, special education teacher)	Multiple, responsive to need.	No
Hadjianastassiou (34)	2001	Quantitative non-randomised	11	UK	Hospital: Accident & Emergency department	To compare personal, peer-comparison feedback, to the 'conventional' departmental one.	Audit of documentation process, then three sets of patient presentations with no feedback, personal peer comparison feedback, and average departmental feedback applied respectively, then re-audit.	Senior house officers	Unclear (written)	Once for each type	No
Helder (62)	2016	Quantitative randomised controlled: <i>cluster</i>	Unclear (799 observations)	Netherlands	Hospital: 3 neonatal/paediatric units	To compare adherence to intravenous (IV) preparation and disinfection protocols before and after the introduction of mutual collegial feedback.	Education, brochure distribution and mutual feedback between colleagues.	Nursing staff	Nursing staff	Multiple	No
Hempel (63)	2014	Quantitative non-randomised : <i>before and after</i>	44	USA	Hospital: emergency medicine	To evaluate if Clinician-Performed Ultrasound scan numbers improve after residents are provided with a personalized peer-comparison feedback.	Personalized peer-comparison feedback sent by email and letter, comparing individual resident ultrasound numbers with their peer group.	Emergency medicine residents (all in PGY-2 through PGY-4).	Unclear	Once	Yes
Hermesen (64)	2012	Quantitative non-randomised : <i>before and after</i>	Unclear (10,545 alerts)	USA	Hospital	To evaluate impact of a Clinical Decision Support System on performance of prospective audit with intervention and feedback.	Implemented a Clinical Decision Support System linked to an Antimicrobial Stewardship Programme. Evaluated the number of intervention attempts in the period before and after the introduction of the Clinical Decision Support System.	Unclear	Clinical Decision Support System (via alerts)	Variable	No
Holmboe (35)	1998	Quantitative non-randomised	Unclear (280)	USA	Hospital: general internal medicine clinic	To examine the effect of an intervention using medical record audits and	Audited medical records and provided written summary of performance (% appropriately performed) for three preventative health interventions, then reviewed medical records to	Residents in general	Auditors (internists).	Multiple	No

		: <i>before and after</i>	medical records)			individualised feedback on compliance with guidelines.	see if any impact on other non-targeted interventions.	internal medicine			
Horowitz (65)	2002	Quantitative non-randomised : <i>before and after</i>	Unclear	USA	Hospital with a four-year Emergency Medicine residency program	To improve inpatients' knowledge/experience of community-acquired pneumonia care, and decrease unnecessary time on intravenous antibiotics and days in hospital, via a feedback intervention to healthcare staff.	Guideline dissemination, education sessions for physicians and nurses (lectures, individualised data, peer discussions), educational brochure for patients from nurses	Attending physicians and house staff, nurses and social workers	Unclear	Unclear	No
Huber (66)	2015	Quantitative non-randomised	Unclear	USA	Hospital	To examine impact of a staff member responsible for feedback delivery on hand hygiene compliance.	Staff member appointed. Evaluation by 'secret shopper' observation and feedback from colleagues.	All staff in acute care facility	Secret shopper	Unclear	No
Konig (67)	2013	Quantitative non-randomised : <i>before and after</i>	Unclear (22,279 patient data records)	Austria	Hospital: 18 Geriatric Acute Care Units	To evaluate the effects of audit and feedback on service delivery and patient functioning.	Standardised documentation and introduced web-based performance feedback with peer comparison reports. Themes in feedback addressed at local and regional meetings.	Geriatric acute care unit staff	Online system (individual) and meetings (general)	Feedback reports every 6 months	No
Langston (68)	2011	Quantitative non-randomised : <i>before and after</i>	Unclear (428 audits)	USA	University hospital: surgery intensive care, neurosurgery intensive care, and surgical intermediate care units	To increase hand hygiene compliance through general and individual feedback to staff.	The audit tool enabled all staff to observe hand hygiene practices of other health care professionals and, when hand hygiene is not performed appropriately, to provide feedback.	Other professional and support staff.	Registered nurses, nursing assistants and unit coordinators	Multiple	No
Luke (69)	2011	Quantitative non-randomised	3	USA	Hospital: occupational health clinic	To evaluate the effects of immediate, personalized performance feedback on	Individual feedback on hand hygiene adherence after observing patient contact. Feedback based on a checklist of adherence with recommended practices, both observed and opportunities	Health-care staff: nurse practitioner, physician assistant, and	Unclear	Multiple (until mastery criteria were met).	No

						adherence with hand hygiene.	missed or incorrectly performed.	medical assistant.			
Marra (70)	2008	Quantitative non-randomised	77 (questionnaire respondents)	Brazil	Private hospital: two adult step-down units	To evaluate hand hygiene compliance following a feedback intervention.	Feedback of unit infection rates to Healthcare Workers (HCWs) in intervention unit. Feedback to individual HCWs showing dispenser use in each patient room. Data added to medical chart, to facilitate peer-comparison.	Health care workers, especially nurses	Nurse manager	Multiple	No
Mautone (71)	2006	Quantitative non-randomised	1	USA	Public middle school (grades 6-8)	To illustrate a model of behavioural consultation used with a public school teacher to improve implementation of instructional procedures in the classroom.	Classroom observation recording teacher and student behaviours, followed by feedback that reviewed session objectives, success in implementing classroom behaviour support plan.	Sixth-grade science teacher	Teacher consultant (author)	Multiple	No
McKenney (72)	2013	Quantitative non-randomised	3	USA	Middle school: general education	To explore the impact of training and performance feedback on integrity of implementing functional analyses procedures.	Functional analyses procedures taught; teachers observed during ongoing classroom instruction; performance feedback given.	Teachers	Consultants	Multiple	No
McLellan (28)	2016	Mixed methods	14	UK	Hospital	To investigate whether and how structured feedback sessions can increase rates of appropriate antimicrobial prescribing by junior doctors.	Individualized, written feedback on appropriateness of trainees' prescribing of antimicrobials, with peer comparison. Writing of behaviour change plans by trainees.	Junior doctors	Senior pharmacist	Twice	Yes
Milanowski (29)	2005	Mixed methods	144 (50 split role and 94 combined role)	USA	Schools	To examine any differences when splitting the feedback role between different feedback givers: either summative evaluation and formative coaching and mentoring from a single person; or the summative role performed by one person and	One group of new teachers received summative evaluation and formative coaching and mentoring from a single person, while for another group the summative role was performed by one person and the coach/mentor role by another.	Newly hired teachers with no prior teaching experience	Peer mentors and managers; or combined feedback from peer evaluators.	Multiple	Yes

						the coach/mentor role by another.					
Minor (73)	2014	Quantitative non-randomised	3	USA	Schools: special education	To improve intervention integrity of behaviour support plan implementation.	Classroom observation (30 minutes) of each teacher–student dyad conducted. Data recorded were analysed to provide an intervention integrity percentage. Feedback included corrective statements and praise, and discussions about problem solving consultations.	Special education teachers	Teaching consultant (first author)	Multiple	No
Mouzakitis (74)	2015	Quantitative non-randomised	4	USA	School: special education	To examine the use of self-monitoring alone and with performance to improve and generalise treatment integrity of individualized behaviour intervention plans.	Teachers were provided with each target student's behaviour intervention plan, and self-monitored their implementation. Feedback provided until the teacher self-monitored with 90% accuracy then, performance feedback was added to self-monitoring.	Special education teachers	Certified behaviour analyst (first author)	Multiple	No
Noell (75)	1997	Quantitative non-randomised	3	USA	Schools: elementary school	To examine the treatment integrity with which general education teachers implemented a reinforcement based intervention designed to improve the academic performance of elementary school students.	Consultant shared student academic performance data (outcome data) and teacher intervention implementation data (process data) and identified the specific treatment steps missed the preceding day and how to improve implementation that day.	Teachers	Consultant	Multiple	No
O'Horo (76)	2012	Quantitative non-randomised	Unclear (3184 individual patients sign-outs)	USA	Hospitals: one general medical and surgical; and one tertiary referral.	To determine whether an electronic handover system and educational interventions or a standard card-based system would provide the most complete, accurate and safe handovers of patient care.	One campus implemented the electronic handover and educational interventions, whereas the other continued to use a card-based system. Residents rotated between the campuses and systems were evaluated for completeness, accuracy, and safety.	Residents	Auditors	One-off	No
Pate (77)	2012	Quantitative non-randomised : <i>before and after</i>	Unclear (275 patient chart reviews)	USA	Hospital	To audit an antimicrobial stewardship program at a long-term acute care hospital.	Post-prescriptive chart audit with intervention and feedback. Nonbinding recommendations given. Infectious Disease consultation was recommended when record review failed to	Medical staff	Medical director for infection control and	Multiple	No

							reveal enough detail to optimise antimicrobial therapy.		director of pharmacy		
Pessoa-Silva (78)	2007	Quantitative non-randomised : <i>before and after</i>	101	Switzerland	Children's hospital: neonatal unit.	To evaluate the impact of a hand hygiene education programme on individual infection risk reduction among neonates.	The hand hygiene program was introduced; compliance was assessed by observational surveys; infection rates were assessed before, during, and after.	Physicians (n=17) and nurses (n=84)	Unclear	Twice after the intervention	No
Proude (79)	2008	Quantitative non-randomised	65	Australia	Hospitals: one feedback, one control	To determine whether individual feedback on current clinical practice improved assessment and management of risky alcohol use in inpatients; and the indirect effects on recording of tobacco smoking and prescription of nicotine replacement therapy.	Medical records of patients admitted by junior medical officers were examined for recording of alcohol-related information. The intervention involved printed individual feedback on their own and their group's performance, while the control site just attended a presentation of their group feedback.	Junior doctors (first 2 years of clinical practice).	Unclear (individual); staff specialist in Addiction Medicine (group).	Multiple	No
Rathel (80) (thesis)	2009	Same study as Rathel 2014									No
Rathel (81) (publication)	2014	Quantitative non-randomised : <i>before and after</i>	4	USA	School: special education classrooms.	To evaluate the impact of e-mailed specific performance feedback on teachers ratio of positive-to-negative communication behaviours; and behaviour-specific praise; and to evaluate if this leads to increased students task engagement.	Classroom observations were conducted at the same time each day using a method to record communication behaviours. The intervention consisted of an initial 30 min meeting with each teacher and a follow up e-mail containing specific performance feedback.	Induction year teachers	First author/researcher	Multiple	No
Redwood (27)	2013	Mixed methods	42	UK	Teaching hospital	To establish whether a Junior Doctor Dashboard providing feedback on prescription warning information and laboratory alerting acceptance rates was effective in changing junior doctors' behaviour.	The intervention group were e-mailed a link to a personal dashboard every week for 4 months. Outcome measures were differences between groups in responses to prescribing warnings (of two severities) and laboratory alerting (of two severities) in the months before and during the intervention.	Junior doctors (below specialty trainee level 3 grade).	Automated feedback	Multiple	Yes

Render (82)	2011	Quantitative non-randomised : <i>before and after</i>	Unclear (174 intensive care units)	USA	Hospitals: 174 intensive care units in 123 hospitals.	To describe implementation of a practice bundle to reduce central-line associated bloodstream infections using infrastructure elements focused on building leadership support, measurement, shared learning, mentoring and teams to move practices.	The practice bundle included multiple strategies to reduce central line-associated bloodstream infections and support for the bundle included recruiting leadership, benchmarked feedback, learning tools and selective mentoring.	Frontline nurses and doctors	Unclear	Unclear	No
Rodriguez (83)	2009	Quantitative non-randomised : <i>before and after</i>	3	USA	School	To reduce problem behaviours for young children at risk for school failure.	Implemented First Step to Success, a "manualized" intervention. Explored the role of performance feedback from FSS coaches on the fidelity of implementation. Student behaviour and teacher implementation fidelity were assessed after coaching and compared to baseline.	Teachers	'First Step to Success' coaches	Multiple	No
Sanetti (84)	2014	Quantitative non-randomised : <i>before and after</i>	3	USA	Education: suburban public middle school	To provide an exploratory evaluation of the effectiveness and feasibility of performance feedback from a school-based consultant to teachers implementing a class wide behavioural intervention.	The intervention in this study consisted of two components: student self-monitoring using DBR-SIS (i.e. skill building) and interdependent group contingency management i.e. positive reinforcement.	Special education teacher and 2 eight-grade teachers	School-based consultant	Multiple times	No
Schwartzberg (85)	2006	Quantitative non-randomised	Unclear	Israel	Hospital: acute secondary care	To evaluate a 3 stage model for changing physicians prescribing habits.	A 3 stage model for changing physicians prescribing habits was implemented: 1) management actions influencing all staff e.g. creation of guidelines, 2) reorganisation of restricted antibiotics prescription authorisation system, 3) new role for clinical pharmacist feeding back to attending doctor using academic detailing strategies and evidence-based pharmacotherapy criteria.	Physicians	Clinical pharmacist	Multiple	No
Suhrheinrich (86)	2010	Quantitative non-randomised	9	USA	Education: three training groups	To assess the benefits of using the Train The Teacher model to disseminate Pivotal Response Training, an evidence-based	Trainers and teachers were taught to use Pivotal Response Training. Trainers observed teacher/student interactions and provided feedback. Trainer and teacher ability to	Special education teachers	Trainers (school members)	Multiple	No

		: <i>before and after</i>				practice for educating children with autism, to school settings.	implement PRT, trainer ability to assess PRT and provide feedback, and student language and behavioural changes were assessed before and after training				
Sullivan (87)	2013	Quantitative non-randomised : <i>before and after</i>	Unclear	USA	Hospital: neonatal Intensive Care Unit	To report the development of a prescribing error feedback programme, and its impact on narcotic prescribing errors.	A front-line multidisciplinary team doing multiple Plan Do Study Act cycles developed a system to communicate prescribing errors directly to providers every two weeks in the NICU.	Fellows, nurse practitioners, physician assistants	Multidisciplinary team via e-mail	Multiple times	No
Tang (88)	2007	Qualitative	21	China	Education	To evaluate feedback communicated in post-observation conferences in teaching practice supervision.	32 post-observation conferences between 21 pairs of supervisors and participants of in-service teacher education programmes, and interviews with supervisors and participants were analysed.	In-service teacher education programme participants	Supervisors	Multiple times	Yes
Witt (89)	1997	Quantitative non-randomised : <i>before and after</i>	4	USA	Education: elementary school	To examine the impact of performance feedback on the implementation of a reinforcement-based treatment by general education teachers.	The study examined the integrity with which 4 general education teachers implemented an intervention designed to improve the academic performance of elementary school students.	Teacher	Consultant	multiple times	No
Zhu (90)	2015	Quantitative non-randomised	4	USA	Education: 4 public elementary schools	To examine the impact of performance feedback on treatment integrity and student outcomes for a standard protocol, class-wide reading intervention for grades 2 to 6.	Consultant observed lessons and measured integrity twice a week. Consultant met teacher to provide feedback on previous session, suggest strengths / improvements and provide corrective feedback on missed items (behaviours). Teacher asked to remind class about missed items.	Teachers (grade 2-5 general education teachers)	Consultants	Multiple	No

Table 4: Literature reviews included in our study.

First author	Year	Study design (as per McGill)	Number of included studies	Setting	Aim	Include in second stage?
Balas (91)	1996	Systematic review / meta-analysis	12	Healthcare	To assess the clinical effect of peer-comparison feedback intervention (profiles) in changing practice patterns.	No
De Vos (92)	2009	Systematic review	21	Hospital	To explore effectiveness of strategies for implementing quality indicators in improving the quality of hospital care.	No
Dulko (93)	2007	Systematic review	16	Hospital	To evaluate available research evidence regarding the effectiveness of audit and feedback as a guideline implementation strategy within nursing.	Yes
Hysong (18)	2009	Meta-analysis	19	Healthcare	To test whether Feedback Intervention Theory explains variability in health care Audit and Feedback research, by examining the relationship between A&F and clinical practice guideline adherence.	Yes
Ista (94)	2013	Systematic review	23	Hospitals	To review comparative evidence for implementation strategies to improve nurses' adherence to pain assessment recommendations.	No
Ivers (3)	2012	Systematic review / meta-analysis (Cochrane)	140	Healthcare settings	To assess the effects of audit and feedback on the practice of healthcare professionals and patient outcomes and to examine factors that may explain variation in the effectiveness of audit and feedback.	Yes
Ivers (4)	2014	Systematic Review	140	Healthcare	To explore the effect of audit and feedback on professional practice over time and explore how optimize the effectiveness of audit and feedback.	Yes
Jamtvædt (36)	2003	Systematic review (Cochrane)	85	Healthcare	To assess the effects of audit and feedback on the practice of healthcare professionals and patient outcomes	No

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Jamtvædt (25)	2006	Systematic review	118	Healthcare	An update of a Cochrane review to assess the effects of audit and feedback.	No
Kluger (5)	1996	Historical review and meta-analysis	131	Various/unclear	To provide a historical review; to conduct a meta-analysis to demonstrate the large variability Feedback Intervention effects on performance; and to account for some of the feedback interventions' variability through a preliminary theory.	Yes
Lavoie (37)	2009	Systematic review	7	Hospital: Emergency medicine	To determine what is currently known about outcome feedback in emergency medicine, including its incidence, impact and modifiers	No
Mugford (38)	1991	Systematic review	36	Healthcare	To establish what is known about the role of feedback of statistical information in changing clinical practice	No
Naikoba (95)	2001	Systematic review	21	Healthcare	To summarise and assess effectiveness of interventions to increase compliance with handwashing in healthcare workers, as a hospital infection control measure.	No
Noell (96)	2014	Meta-analysis	29	Schools	To examine procedures, including performance feedback alone or in combination, to improve treatment plan implementation.	No
Rogers (19)	2015	Systematic review	24	Hospital: Emergency medicine	To assess the effect of audit and feedback on emergency physician performance and to identify features critical to success.	Yes
Saedon (97)	2012	Systematic Review	15	Healthcare: Postgraduate medical training	To elucidate the impact of feedback on the effectiveness of workplace-based assessments in postgraduate medical training	No
Shojania (39)	2010	Systematic review	28	Healthcare	To quantify the expected magnitude of improvements in processes of care from computer reminders delivered to clinicians during their routine activities.	No
Solomon (98)	2012	Meta-analysis	36	Education: Classroom	To review applications of performance feedback in school settings and catalogue the various effects of different characteristics of performance feedback.	No
van de Ridder (13)	2015	Meta-review	46	Medicine: medical training	To explore which variables in the feedback process influence either the first or subsequent phases in this process or a second performance of the same task	No
Veloski (99)	2006	Systematic review	41	Healthcare	To summarise evidence related to the impact of assessment and feedback on physicians clinical performance	No

Table 5: Framework describing key components of Feedback Interventions (FIs) and the sub-components of Audit, Feedback, Goal-Setting process, together with a summary of evidence outlining 'good practice' from the included papers. In the column headed 'Strength of the Evidence', we have formed a judgment about the strength of the evidence found via this scoping review. We use a star system to show our summary judgment (1 star: based on theory but not disproved by data; 2 star: based on limited empirical data; 3 star: based on a high quality evidence synthesis; 4 star: based on multiple high quality evidence syntheses; 5 star: Unlikely to be 'disproved'). Note that these star system descriptors must be considered indicative only, however, since sometimes there was a high quality evidence synthesis available but only a small part of it focussed on this specific aspect, and so we are only drawing on arguments that may not be as strongly supported with data.

Category	Sub-category	Example/level	Summary of evidence for designers of Feedback Interventions (FI) for Early Career Professionals (ECPs)	Strength of the evidence
1. Audit	1.1 Complexity of task chosen	Simple, complicated, complex	<ul style="list-style-type: none"> Professional practice is characterised by complex tasks, such as those involving judgment or novelty. Published studies rarely define the type of task or behaviour targeted by feedback but the impact is likely to vary by task: for example, the impact of a Feedback Intervention (FI) is probably smaller for more complex tasks (5). 	*
	1.2 Type of task chosen	Memory task, physical task	<ul style="list-style-type: none"> Many included studies used compliance with a policy as their outcome measure. For ECPs there may be a greater focus on compliance than autonomous decision making but, as expertise develops, judging when it is appropriate to deviate from a policy may be necessary within professional practice (27). 	*
	1.3 Nature of data to be collected	Quantitative, qualitative, mixed	<ul style="list-style-type: none"> Different types of data may be selected when providing feedback for different purposes but the rationale for the choice is rarely articulated (29). The perceived focus of the feedback exercise is influenced by the choice of feedback data (88) but recipient perceptions are sometimes hard to predict (27) and may depend on context, for example whether performance data may be perceived as linked to assessment judgments or probation (63). Quantitative data seem to pre-empt more 'summative' conversations about performance, whereas qualitative data may set up more developmental conversations. Recipients may require support to interpret and respond to quantitative data in particular (29). Feedback criteria can be embedded within a learning process, for example by setting expectations about performance at the outset (33). 	*
	1.4 Metric importance to the intended recipient	High, medium, low	<ul style="list-style-type: none"> Feedback metrics that are aligned to the priorities of the recipient and/or the organisation are likely to have greater impact, as is feedback that is solicited by the recipient (33). Recipients tend to value performance data that is directly relevant to their work, for example on specific practice scenarios (27, 33, 88). It is important to consider whether 'more' or 'less' of the targeted behaviour is always desirable or whether an optimal level may apply (63). 	*
	1.5 Data credibility	High, medium, low	<ul style="list-style-type: none"> External guidelines or standards were often used as credible sources of practice standards (31, 60, 63) and sometimes data were signed off or sent by a senior practitioner or group/committee to lend credibility. When credibility of feedback data is open to challenge (e.g. inconsistent messages, second hand sources, lacking awareness of the working context), the feedback process could be undermined (29, 30, 33). 	**

			<ul style="list-style-type: none"> For ECPs who often work under supervision, performance data are sometimes not a fair reflection of ECP's own clinical practice, since they may be enacting the wishes of their seniors (27). Where teamwork or shift work is common, it may be hard to attribute particular decisions/outcomes to individuals (60). Feedback messages may be undermined by contextual cues or other feedback sources (5). 	
	1.6 Baseline performance	Very low, low, average, high, very high	<ul style="list-style-type: none"> If the feedback 'sign' is extremely positive or negative (i.e. performance is very high or low), arousal is likely to be greater than an average or absent feedback sign (5). Feedback is most effective when baseline performance is low (3, 4, 19) or moderate (19), which is likely for ECPs. However, if baseline performance is very low, then rapid improvement is needed to sustain engagement with the task; and if baseline performance is already high or very high, it is likely that effort will be maintained or reduced (5). 	***
2. Feedback intervention	2.1 Feedback format	Electronic, verbally, written, graphical. Public, confidential	<ul style="list-style-type: none"> Effectiveness of feedback seems to depend on how it is provided (3). Written feedback appears more effective than verbal or graphical delivery (18), although a combination may be beneficial (3). This may be because written or electronic sharing allows attention to focus on the task, whereas face-to-face feedback may trigger meta-task processes and affective reactions (5, 18). Public feedback and peer comparisons are less likely to be effective because they may direct attention to meta-task processes (5, 27), although this requires further research (3). 	***
	2.2 Comparison to other data	To peers, past performance, explicit standard(s)	<ul style="list-style-type: none"> Individuals who are performing better than their peers may not strive to improve further or may even decrease effort (5, 27). Comparison to past performance (feedback on progress over time) is likely to direct attention to the task and therefore augment performance (5). If there is no clear standard against which to compare feedback (e.g. a new task), then there may be little motivation to change, unless goals are provided (5). 	**
	2.3 Judgment made on data	None, praise, displeasure	<ul style="list-style-type: none"> With cognitively demanding tasks, which are common in professional practice, both praise and discouragement may increase attention to meta-task processes and therefore lessen impact (5). 	*
	2.4 Content of feedback	Specific, generic	<ul style="list-style-type: none"> A number of authors advocate specific, individualised feedback (18, 33) suggesting a belief that this is likely to be effective. However, feedback that is too specific may direct attention below the level necessary for optimal performance (5). According to FIT, feedback on group performance should augment performance because it diverts attention away from the self (5) but it may lack meaning for an individual. 	*
	2.5 Likelihood of feedback to be perceived as a threat	High, medium, low	<ul style="list-style-type: none"> Feedback, particularly negative feedback, may be perceived as a threat to self-esteem or to external rewards/punishments (5). Study participants acknowledged concern about how data would be used e.g. for clinical accountability, or to enforce disciplinary action (27). Feedback that is non-punitive, non-evaluative and non-threatening (18, 33, 93) will reduce the perception of threat. The benefits of using 'authoritative' sources to increase the perceived credibility of feedback information (30), must be weighed up against the risks of this making the feedback seem more threatening. No benefits were observed when formative and summative elements of feedback were separated, in an attempt to encourage honesty and openness about weaknesses and the setting of challenging goals (29). 	**

	2.6 Correct solution information	Present, absent	<ul style="list-style-type: none"> Providing a 'correct solution' as part of feedback is thought to increase its likely impact (5, 18) by focussing attention on target behaviour. However, 'correct solutions' may be challenging to identify within professional practice, where complex judgments in a messy practice context are common. 	***
	2.7 Timing and frequency of feedback	One off, multiple times Within a week, after more than a week	<ul style="list-style-type: none"> Feedback is thought to be most effective when presented more than once (3, 4, 18, 33, 56). More feedback, provided closer to the performance event, was felt to be beneficial (28), although presumably there is an upper limit for frequency. Feedback can sometimes be concurrent with the task (93) but most studies provided feedback more than one week later (19). 	****
3. Goal-setting	3.1 Presence or absence of goal-setting	Present, absent	<ul style="list-style-type: none"> The included papers suggested that knowing what to do with feedback is as important as receiving it (28). Some included empirical studies did not have a goal setting stage beyond feedback (31); for others, this was the main focus (88). Feedback is thought to be more effective when combined with reflection and/or goals and an action plan (3, 5, 18, 19). Explicit targets without action plans may not add benefit (4). Action planning may be especially important when feedback is hard to interpret (5). 	****
	3.2 Presence of a reviewer to support goal-setting	Present, absent	<ul style="list-style-type: none"> Most included studies involved a reviewer in goal-setting (29): few studies involved goal setting without support. This may reflect implicit theories about the need for support in this step, although many studies also conflated feedback and goal-setting and the reviewer's primary role was often unclear. 	**
	3.3 Relationship to reviewer	Senior colleague/supervisor, peer, external person	<ul style="list-style-type: none"> The reviewer needed to be perceived as credible, which was often judged based on seniority (3, 4), although the evidence is unclear (19), context familiarity (30) and facilitation skills (29). Goal-setting enabled reviewers to make their professional knowledge explicit through dialogue (88) but required personality compatibility (29). 	***
	3.4 Nature of goal	Clarity and degree of challenge	<ul style="list-style-type: none"> The reviewer should direct attention to task processes rather than metatask processes (5, 18). 	*
	3.5 Tailoring of goal setting conversation to individuals	Standardised approach or tailoring, tailoring permissible	<ul style="list-style-type: none"> Feedback may not work in the same way for all recipients and/or settings, so tailoring is recommended (19, 88), which may require prior knowledge. Reviewers often had to assess whether a professional behaviour was applicable to that practice scenario (33). 	**
	3.6 Nature of conversation	Supportive, combination of support and challenge, challenge only	<ul style="list-style-type: none"> According to FIT, in reacting to feedback, ECPs have several behavioural options e.g. strive to attain the goal, change the goal, reject the feedback, or abandon commitment to the goal (5). A quality goal-setting conversation can help learners to identify the gap between current and desired performance and agree a strategy for change (88). Cues that foster high self-efficacy may direct attention back to the task and cause people to invest more effort (5). Some authors (88) assume that difficult, personal topics are discussed during goal-setting (e.g. commitment, attitude) but this seems at odds with FIT (5), which advocates avoiding attention to meta-task. 	*
	3.7 Recipient ownership of goal setting	Low, medium, high	<ul style="list-style-type: none"> Involvement of recipients in the process of goal setting was thought important to maximise impact by some authors (88, 93) and make asymmetric power relations (which are probably inevitable where only one party's work is analysed) more balanced (88). 	*

			<ul style="list-style-type: none"> • Learning through discovery was theorised to be more powerful and sustainable than feedback from an external agent (5). 	
	3.8 Acceptance of goals suggested	Complete acceptance, partial acceptance, rejection	<ul style="list-style-type: none"> • Goals are unlikely to be accepted or prioritised if the immediate relevance to practice setting is unclear (18, 27, 28, 30, 60, 88). • It seemed important for recipients to be able to discuss the performance context (27, 29) since sometimes apparent 'poor performance' was the most appropriate action/judgment when considered in context (27, 28). • Motivation for behavioural change may be secured by increasing participant's perceptions of best practice; and/or increasing the standard of their typical practice (28). • Acceptance of goals depended on whether they were seen as beyond the scope of responsibility or possibility of an ECP (27, 88). 	**
	3.9 Successful completion of goals set	Success, partial success, failure	<ul style="list-style-type: none"> • Successful completion of goals may depend on context and may be beyond the control of ECPs (3, 28, 30), even if there is strong intention to change behaviour. • Feedback on metrics over which ECPs have no behavioural control is likely to lead to disengagement (27). • Involvement of end users (e.g. patients/families) in feedback processes may help secure commitment to change (32). • Some mechanisms underpinning poor uptake/effectiveness of feedback interventions were complex and only picked up via qualitative process evaluation (28, 30). • If working harder fails and they are still sufficiently motivated to do so, ECPs may reflect on the situation and reframe the problem, leading to a new plan for improved performance (5). • Motivation to change targeted behaviour is relatively understudied (93). • When a FI increases performance through an increase in task motivation the effect may depend on a continuous FI (5), whereas for some other mechanisms a 'one off' FI may be effective. 	*

Table 6: Summary of the Feedback Framework, comparing FIT (5) and the new knowledge provided through our study with ECPs

Category	What FIT says	What our study with ECPs adds
1. Audit	<p>Choosing the right measure is important.</p> <p>If baseline performance is very low, then rapid improvement is needed to sustain engagement with the task.</p> <p>Feedback messages may be undermined by contextual cues.</p>	<p>ECPs are more likely to have a low baseline performance and may be disheartened more easily than more senior colleagues, without appropriate support, so choice of measure is even more important for ECPs.</p> <p>The relevant contextual cues probably differ for ECPs, especially given their dual goals of training and practice, which may be in tension.</p>
2. Feedback intervention	<p>Comparison to past performance and external standards, and feedback on group performance, is likely to be beneficial.</p> <p>Praise and discouragement, face-to-face feedback, public feedback and peer comparisons may well be detrimental.</p>	<p>Past performance data may not exist for ECPs, clear expected standards may not be available or known about, and support networks may not yet be in place, so ECPs will need additional help to gain the most benefit from feedback.</p> <p>ECPs may have less confidence in their abilities and be more alert to praise or discouragement, so feedback must explicitly steer them back to task and avoid affective reactions.</p>
3. Goal-setting	<p>Feedback likely to be more effective when combined with reflection and/or goals and an action plan, especially when feedback information is hard to interpret or requires a different way of working.</p> <p>Cues that foster high self-efficacy may result in more effort.</p>	<p>FIT does not place much emphasis on the goal-setting stage but this seems critically important for ECPs.</p> <p>ECPs are more likely to find feedback hard to interpret but are also more likely to be open to different ways of working, since their habits are less long-established.</p>